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# Toxicological Profile for

## ARSENIC

**U.S. DEPARTMENT OF HEALTH & HUMAN SERVICES**  
Public Health Service  
Agency for Toxic Substances and Disease Registry

**TP-92/02**



# **TOXICOLOGICAL PROFILE FOR ARSENIC**

Prepared by:

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Under Subcontract to:

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Prepared for:

**U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES**  
**Public Health Service**  
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## **UPDATE STATEMENT**

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Toxicological profiles are revised and republished as necessary, but no less than once every three years. For information regarding the update status of previously released profiles, contact ATSDR at:

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## CONTENTS

FOREWORD .....	v
CONTRIBUTORS .....	vii
LIST OF FIGURES .....	xiii
LIST OF TABLES .....	xv
<b>1. PUBLIC HEALTH STATEMENT .....</b>	<b>1</b>
1.1 WHAT IS ARSENIC? .....	1
1.2 WHAT HAPPENS TO ARSENIC WHEN IT ENTERS THE ENVIRONMENT? .....	2
1.3 HOW MIGHT I BE EXPOSED TO ARSENIC? .....	2
1.4 HOW CAN ARSENIC ENTER AND LEAVE MY BODY? .....	3
1.5 HOW CAN ARSENIC AFFECT MY HEALTH? .....	4
1.6 IS THERE A MEDICAL TEST TO DETERMINE WHETHER I HAVE BEEN EXPOSED TO ARSENIC? .....	5
1.7 WHAT RECOMMENDATIONS HAS THE FEDERAL GOVERNMENT MADE TO PROTECT HUMAN HEALTH? .....	6
1.8 WHERE CAN I GET MORE INFORMATION? .....	6
<b>2. HEALTH EFFECTS .....</b>	<b>7</b>
2.1 INTRODUCTION .....	7
2.2 DISCUSSION OF HEALTH EFFECTS BY ROUTE OF EXPOSURE .....	7
2.2.1 Inhalation Exposure .....	9
2.2.1.1 Death .....	9
2.2.1.2 Systemic Effects .....	16
2.2.1.3 Immunological Effects .....	19
2.2.1.4 Neurological Effects .....	20
2.2.1.5 Developmental Effects .....	20
2.2.1.6 Reproductive Effects .....	21
2.2.1.7 Genotoxic Effects .....	21
2.2.1.8 Cancer .....	21
2.2.2 Oral Exposure .....	22
2.2.2.1 Death .....	41
2.2.2.2 Systemic Effects .....	41
2.2.2.3 Immunological Effects .....	46
2.2.2.4 Neurological Effects .....	46
2.2.2.5 Developmental Effects .....	47
2.2.2.6 Reproductive Effects .....	48
2.2.2.7 Genotoxic Effects .....	48
2.2.2.8 Cancer .....	48
2.2.3 Dermal Exposure .....	50
2.2.3.1 Death .....	50
2.2.3.2 Systemic Effects .....	50
2.2.3.3 Immunological Effects .....	52
2.2.3.4 Neurological Effects .....	52
2.2.3.5 Developmental Effects .....	52
2.2.3.6 Reproductive Effects .....	52

2.2.3.7	Genotoxic Effects	53
2.2.3.8	Cancer	53
2.3	TOXICOKINETICS	53
2.3.1	Absorption	53
2.3.1.1	Inhalation Exposure	53
2.3.1.2	Oral Exposure	54
2.3.1.3	Dermal Exposure	54
2.3.2	Distribution	55
2.3.2.1	Inhalation Exposure	55
2.3.2.2	Oral Exposure	55
2.3.2.3	Dermal Exposure	55
2.3.2.4	Other Routes of Exposure	55
2.3.3	Metabolism	56
2.3.4	Excretion	57
2.3.4.1	Inhalation Exposure	57
2.3.4.2	Oral Exposure	57
2.3.4.3	Dermal Exposure	57
2.3.4.4	Other Routes of Exposure	58
2.4	RELEVANCE TO PUBLIC HEALTH	58
2.5	BIOMARKERS OF EXPOSURE AND EFFECT	69
2.5.1	Biomarkers Used to Identify or Quantify Exposure to Arsenic	70
2.5.2	Biomarkers Used to Characterize Effects Caused by Arsenic	71
2.6	INTERACTIONS WITH OTHER CHEMICALS	72
2.7	POPULATIONS THAT ARE UNUSUALLY SUSCEPTIBLE	73
2.8	METHODS FOR REDUCING TOXIC EFFECTS	73
2.8.1	Reducing Peak Absorption Following Exposure	73
2.8.2	Reducing Body Burden	74
2.8.3	Interfering with the Mechanism of Action for Toxic Effects	74
2.9	ADEQUACY OF THE DATABASE	75
2.9.1	Existing Information on Health Effects of Arsenic	75
2.9.2	Identification of Data Needs	78
2.9.3	On-going Studies	83
3.	CHEMICAL AND PHYSICAL INFORMATION	85
3.1	CHEMICAL IDENTITY	85
3.2	PHYSICAL AND CHEMICAL PROPERTIES	85
4.	PRODUCTION, IMPORT, USE, AND DISPOSAL	95
4.1	PRODUCTION	95
4.2	IMPORT/EXPORT	95
4.3	USE	95
4.4	DISPOSAL	97
5.	POTENTIAL FOR HUMAN EXPOSURE	99
5.1	OVERVIEW	99
5.2	RELEASES TO THE ENVIRONMENT	99
5.2.1	Air	102
5.2.2	Water	102
5.2.3	Soil	102
5.3	ENVIRONMENTAL FATE	103
5.3.1	Transport and Partitioning	103

5.3.2	Transformation and Degradation .....	103
5.3.2.1	Air .....	103
5.3.2.2	Water .....	103
5.3.2.3	Soil .....	104
5.4	LEVELS MONITORED OR ESTIMATED IN THE ENVIRONMENT .....	104
5.4.1	Air .....	104
5.4.2	Water .....	104
5.4.3	Soil .....	105
5.4.4	Other Environmental Media .....	105
5.5	GENERAL POPULATION AND OCCUPATIONAL EXPOSURE .....	105
5.6	POPULATIONS WITH POTENTIALLY HIGH EXPOSURES .....	106
5.7	ADEQUACY OF THE DATABASE .....	106
5.7.1	Identification of Data Needs .....	106
5.7.2	On-going Studies .....	108
6.	ANALYTICAL METHODS .....	109
6.1	BIOLOGICAL MATERIALS .....	109
6.2	ENVIRONMENTAL SAMPLES .....	113
6.3	ADEQUACY OF THE DATABASE .....	113
6.3.1	Identification of Data Needs .....	118
6.3.2	On-going Studies .....	118
7.	REGULATIONS AND ADVISORIES .....	119
8.	REFERENCES .....	125
9.	GLOSSARY .....	173
APPENDICES		
A.	USER'S GUIDE .....	A-1
B.	ACRONYMS, ABBREVIATIONS, AND SYMBOLS .....	B-1
C.	PEER REVIEW .....	C-1

## **1. PUBLIC HEALTH STATEMENT**

This Statement was prepared to give you information about arsenic and to emphasize the human health effects that may result from exposure to it. The Environmental Protection Agency (EPA) has identified 1,300 sites on its National Priorities List (NPL). Arsenic has been found in at least 781 of these sites. However, we do not know how many of the 1,300 NPL sites have been evaluated for arsenic. As EPA evaluates more sites, the number of sites at which arsenic is found may change. This information is important for you to know because arsenic may cause harmful health effects and because these sites are potential or actual sources of human exposure to arsenic.

When a chemical is released from a large area, such as an industrial plant, or from a container, such as a drum or bottle, it enters the environment as a chemical emission. This emission, which is also called a release, does not always lead to exposure. You can be exposed to a chemical only when you come into contact with the chemical. You may be exposed to it in the environment by breathing, eating, or drinking substances containing the chemical or from skin contact with it.

If you are exposed to a hazardous chemical such as arsenic, several factors will determine whether harmful health effects will occur and what the type and severity of those health effects will be. These factors include the dose (how much), the duration (how long), the route or pathway by which you are exposed (breathing, eating, drinking, or skin contact), the other chemicals to which you are exposed, and your individual characteristics such as age, sex, nutritional status, family traits, life style, and state of health.

### **1.1 WHAT IS ARSENIC?**

Arsenic is a naturally-occurring element. Pure arsenic is a gray metal-like material which is usually found in the environment combined with other elements such as oxygen, chlorine, and sulfur. Arsenic combined with these elements is called inorganic arsenic. Arsenic combined with carbon and hydrogen is called organic arsenic. You should know the difference between inorganic and organic arsenic because the organic forms are usually less harmful than the inorganic forms.

Most inorganic and organic arsenic compounds are white or colorless powders that do not evaporate. They have no smell, and most have no special taste. Thus, you usually cannot tell if arsenic is present in your food, water, or air.

Inorganic arsenic occurs naturally in many kinds of rock, especially in ores that contain copper or lead. When these ores are heated at smelters to get the copper or lead, most of the arsenic enters the air as a fine dust. Smelters collect this dust and purify the arsenic for several uses. The main use is as a preservative for wood to make it resistant to rotting and

## 1. PUBLIC HEALTH STATEMENT

decay. Arsenic is also used to make several types of insect killers and weed killers, such as Ansar<sup>®</sup>, Scorch<sup>®</sup>, Phytar<sup>®</sup>, Bueno<sup>®</sup>, Crab-E-Rad<sup>®</sup>, Premix<sup>®</sup>, and others.

You can find more information on the sources, properties, and uses of arsenic in Chapters 3 and 4.

### 1.2 WHAT HAPPENS TO ARSENIC WHEN IT ENTERS THE ENVIRONMENT?

Arsenic can enter the environment in several ways. Even though it does not evaporate, arsenic can get into air as dust. This can happen when smelters heat ores containing arsenic, when people burn any material containing arsenic, or when wind blows soil that contains arsenic into the air. Once in the air, the arsenic particles will travel with the wind for a while, but will then settle back to the ground. Most arsenic compounds can also dissolve in water. Thus, arsenic can get into lakes, rivers, or underground water by dissolving in rain or snow, or through the discharge of industrial wastes. Some of the arsenic will stick to the sediment on the bottom of the lake or river, and some will be carried along by the water.

Arsenic is not broken down or destroyed in the environment. However, it can change from one form to another by natural chemical reactions, and also by the action of bacteria that live in soil or water. Although some fish and shellfish build up arsenic in their tissues, most of this is in a form (often called "fish arsenic") that is not toxic.

You can find more information on how arsenic gets into the environment and how it behaves in air, soil, and water in Chapters 4 and 5.

### 1.3 HOW MIGHT I BE EXPOSED TO ARSENIC?

Because arsenic is a natural part of the environment, low levels of arsenic are present in soil, water, food, and air. Soil usually contains the most, with average levels of about 5,000 parts of arsenic per billion parts of soil (ppb). Levels in food are usually about 20–140 ppb and levels in water are about 2 ppb. Levels in air are usually about 0.02–0.10 micrograms per cubic meter. Thus, you normally take in small amounts of arsenic in the air you breathe, the water you drink, and the food you eat. Of these, food is usually the largest source. You are also likely to swallow small amounts of dust or dirt each day, so this is another way you can be exposed to arsenic. The total amount you take in from these sources is probably about 50 micrograms each day.

#### 1. PUBLIC HEALTH STATEMENT

In addition to the normal levels of arsenic in air, water, soil, and food, you could be exposed to higher levels in several ways, such as the following:

- Some areas of the country contain unusually high natural levels of arsenic in rock, and this can lead to unusually high levels of arsenic in soil or water. If you live in an area like this, you could take in above-average amounts of arsenic from the soil or from the water.
- Some hazardous waste sites contain large quantities of arsenic. If the material is not properly disposed of, it can get into surrounding water, air, or soil. If you live near such a site, you could be exposed to above-average levels of arsenic from these media.
- If you work in an occupation that involves arsenic production or use (for example, copper or lead smelting, wood treating, pesticide application), you could be exposed to above-average levels of arsenic during your work. The government estimates that about 55,000 people may be exposed in this way.
- If you saw or sand arsenic-treated wood, you could inhale some of the sawdust into your nose or throat. Similarly, if you burn arsenic-treated wood, you could inhale arsenic in the smoke.
- In the past, several kinds of products used in the home (rat poison, ant poison, weed killer, some types of medicines) had arsenic in them. However, most of these uses of arsenic have ended, so you are not likely to be exposed from home products any longer.

You can find more information on how you may be exposed to arsenic in Chapter 5.

#### 1.4 HOW CAN ARSENIC ENTER AND LEAVE MY BODY?

If you swallow arsenic in water, soil, or food, most of the arsenic quickly enters into your body. This is the most likely way for you to be exposed near a waste site. If you breathe air that contains arsenic dusts, many of the dust particles settle onto the lining of the lungs. Most of the arsenic in these particles is then taken up from the lungs into the body. You might be exposed in this way near waste sites where arsenic-contaminated soils are allowed to blow into the air. If you get arsenic-contaminated soil or water on your skin, only a small amount will go through your skin into your body, so this is usually not of concern.

## 1. PUBLIC HEALTH STATEMENT

If you are exposed to arsenic, your liver changes some of this to a less harmful organic form. Both inorganic and organic forms leave your body in your urine. Most of the arsenic will be gone within several days, although some will remain in your body for several months or even longer.

You can find more information on how arsenic enters and leaves your body in Chapter 2.

### 1.5 HOW CAN ARSENIC AFFECT MY HEALTH?

Inorganic arsenic has been recognized as a human poison since ancient times, and large oral doses (above 60,000 ppb in food or water) can produce death. If you swallow lower levels of inorganic arsenic (ranging from about 300 to 30,000 ppb in food or water), you may experience irritation of your stomach and intestines, with symptoms such as pain, nausea, vomiting, and diarrhea. Other effects you might experience from swallowing arsenic include decreased production of red and white blood cells, abnormal heart rhythm, blood-vessel damage, and impaired nerve function causing a "pins and needles" sensation in your hands and feet. Although there is no good evidence that arsenic can injure pregnant women or their fetuses, studies in animals show that doses of arsenic that are large enough to cause illness in pregnant females may cause low birth weight, fetal malformations, or even fetal death.

Perhaps the single most characteristic effect of long-term oral exposure to inorganic arsenic is a pattern of skin changes. This includes a darkening of the skin and the appearance of small "corns" or "warts" on the palms, soles, and torso. While these skin changes are not considered to be a health concern in their own right, a small number of the corns may ultimately develop into skin cancer. Swallowing arsenic has also been reported to increase the risk of cancer in the liver, bladder, kidney, and lung. The Department of Health and Human Services determined that arsenic is a known carcinogen. The International Agency for Research on Cancer (IARC) has determined that arsenic is carcinogenic to humans. The EPA has determined that arsenic is a human carcinogen. Both the EPA and the National Toxicology Program (NTP) have classified arsenic as a known human carcinogen.

If you breathe high levels of inorganic arsenic, you are likely to experience a sore throat and irritated lungs. You may also develop some of the skin effects mentioned above. The exposure level that produces these effects is uncertain, but is probably above 100 micrograms per cubic meter. However, these effects are usually not serious. Of much greater concern is the ability of inhaled inorganic arsenic to increase the risk of lung cancer. This has been seen mostly in humans exposed to arsenic in or around smelters. People who live near smelters, chemical factories, or waste sites with arsenic may have increased risk of lung cancer as well.

## 1. PUBLIC HEALTH STATEMENT

If you have direct skin contact with inorganic arsenic compounds, your skin may become irritated with some redness and swelling. However, it does not appear that skin contact is likely to lead to any serious internal effects.

Despite all the adverse health effects associated with inorganic arsenic exposure, there is some evidence that the small amounts of arsenic in the normal diet (10–50 ppb) may be beneficial to your health. For example, animals fed a diet with unusually low concentrations of arsenic did not gain weight normally. They also became pregnant less frequently than animals fed a diet containing a normal amount of arsenic. Further, the offspring from these animals tended to be smaller than normal, and some died at an early age. However, no cases of arsenic deficiency in humans have ever been reported.

Almost no information is available on the effects of organic arsenic compounds in humans. Studies in animals show that most organic arsenic compounds are less toxic than the inorganic forms. However, high doses can produce some of the same effects. Thus, if you are exposed to high doses of an organic arsenic compound, you might develop nerve injury, stomach irritation, or other effects, but this is not known for certain.

You can find more information on the health effects of inorganic and organic arsenic in Chapter 2.

### **1.6 IS THERE A MEDICAL TEST TO DETERMINE WHETHER I HAVE BEEN EXPOSED TO ARSENIC?**

Several sensitive and specific tests can measure arsenic in your blood, urine, hair, or fingernails, and these tests are often helpful in determining if you have been exposed to above-average levels of arsenic. These tests are not usually performed in a doctor's office, but require sending the sample to a testing laboratory.

Measurement of arsenic in your urine is the most reliable means of detecting arsenic exposures that you experienced within the last several days. Most tests measure the total amount of arsenic present in your urine. Sometimes this can be misleading, because the nonharmful forms of arsenic in fish and shellfish can give a high reading even if you have not been exposed to a toxic form of arsenic. For this reason, laboratories sometimes use a more complicated test to separate "fish arsenic" from other forms. Because most arsenic leaves your body within a few days, analysis of your urine cannot detect if you were exposed to arsenic in the past. Tests of your hair or fingernails can tell if you were exposed to high levels over the past 6–12 months, but these tests are not very useful in detecting low level exposures. If high levels of arsenic are detected, this shows that you have been exposed, but unless more is known about when you were exposed and for how long, it is usually not possible to predict whether you will have any harmful health effects.

## 1. PUBLIC HEALTH STATEMENT

You can find more information on how arsenic can be measured in your hair, urine, nails, and other tissues in Chapters 2 and 6.

### **1.7 WHAT RECOMMENDATIONS HAS THE FEDERAL GOVERNMENT MADE TO PROTECT HUMAN HEALTH?**

The federal government has taken several steps to protect humans from arsenic. First, EPA has set limits on the amount of arsenic that industrial sources can release into the environment. Second, EPA has restricted or canceled many of the uses of arsenic in pesticides and is considering further restrictions. Third, EPA has set a limit of 50 ppb for arsenic in drinking water. EPA is currently reviewing this value and may lower it. Finally, the Occupational Safety and Health Administration (OSHA) has established a maximum permissible exposure limit of 10 micrograms per cubic meter for airborne arsenic in various workplaces that use inorganic arsenic.

You can find more information on regulations and guidelines that apply to arsenic in Chapter 7.

### **1.8 WHERE CAN I GET MORE INFORMATION?**

If you have any more questions or concerns, please contact your community or state health or environmental quality department or:

Agency for Toxic Substances and Disease Registry  
Division of Toxicology  
1600 Clifton Road NE, E-29  
Atlanta, Georgia 30333

This agency can also provide you with information on the location of the nearest occupational and environmental health clinic. These clinics specialize in the recognition, evaluation, and treatment of illnesses resulting from exposure to hazardous substances.